1. ISSUES, GOALS, AND OBJECTIVES

INTRODUCTION

This *Joint DOE-EPRI Strategic Research and Development Plan to Optimize U.S. Nuclear Power Plants* was developed by the U.S. Department of Energy (DOE) and EPRI to address various technical issues that have arisen from the operation of nuclear energy plants, particularly the observed degradation of materials in various nuclear plant components and structures, and obsolescence of selected components and systems. Additionally, institutional issues play a role in shaping both the current importance and the future prospects of nuclear energy in the U.S. and the world. These issues affect decision-making concerning nuclear energy R&D.

ISSUES

The United States is in a period of dynamic change in the electricity sector. With the deregulation of electricity production, many unprecedented issues are challenging utilities, regulators, and the Federal Government. New technologies are altering the fuel choices made by utility planners. Environmental laws are causing the closure of older fossil-fuel plants, and have caused a major realignment in the U.S. nuclear power industry in order to compete in the new environment. Short-term energy deficiencies have been experienced in parts of the country, resulting in brownouts and blackouts. For nuclear energy, the change has been revitalizing: despite predictions to the contrary, deregulation has had a net positive impact on nuclear energy. It has challenged nuclear energy to address anew its greatest challenges: high capital cost, outdated regulations, and resolution of spent fuel disposal issues. It has also brought to the fore nuclear energy's inherent advantages such as high reliability as a baseload generator, low production costs (particularly fuel costs), stable and plentiful fuel supply, minimal vulnerability to cost fluctuations and cost increases from fuel volatility, environmental regulations, etc. Many issues remain that will continue to shape the U.S. energy supply sector. This section discusses these issues and the role of nuclear energy R&D in addressing these issues.

Reducing Greenhouse Gas Emissions

Environmental issues associated with the burning of fossil fuels, including global climate change, are increasing in importance. Power plants that burn fossil fuels to produce electricity emit sulfur oxides and "greenhouse gases" (GHG) such as carbon dioxide and nitrogen oxide, which are associated with global climate change. To reduce the GHG emissions that contribute to this problem, President Clinton presented his Climate Change Proposal on October 22, 1997. Key elements of this proposal included lowering current emission rates to 1990 levels by 2008-2012, and reducing emissions to below 1990 levels in the five-year period after 2012. The December 1997 Kyoto Protocol called for even more strict reductions, to 7% below 1990 levels for the U.S. by 2008-2012. Achieving 1990 levels or less between 2008 and 2012 will be a formidable task because the emissions are projected to rise by about 35 percent for this period in the "business as usual" case.[6]

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Although the U.S. Senate has not ratified the treaty amendment that would impose the Kyoto Protocol, international pressure will continue for reducing fossil fuel emissions. Accomplishing such reductions will require development of a comprehensive strategy that combines increased energy efficiency with greater use of cleaner, non-emitting energy sources, such as nuclear energy and renewable energy.

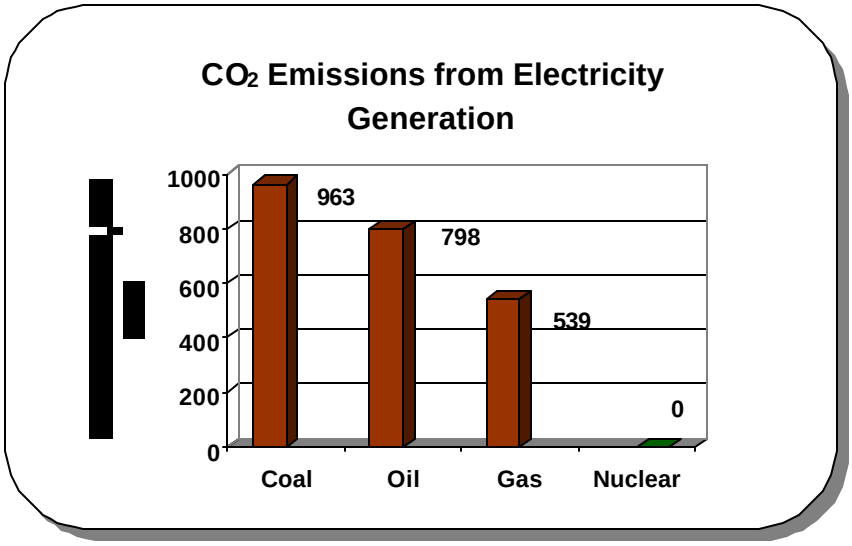

Figure 1-1: Carbon Dioxide Emissions from Electricity Generation
Source: EIA Annual Energy Outlook 2000

Nuclear power plants do not emit GHG (Figure 1-1), so continuing their operation for an extended period greatly helps reduce future GHG emissions. The November 5, 1997, report of the Energy Research and Development Panel of the President's Committee of Advisors on Science and Technology (PCAST) stated:

> "To reduce GHG emission and ensure that the United States has the capacity to achieve internationally agreed-to targets, it is important to pursue R&D that will help determine whether nuclear fission can become a stabilized and later an expanding contributor to this goal."

That challenge of achieving reduced levels becomes even more daunting without nuclear energy. By avoiding the need to burn additional fossil fuels, America's nuclear plants reduced total U.S. carbon emissions by 168 million metric tons of carbon in 1999. Presented another way, generating 1 million kilowatt-hours of electricity produces about 150 metric tons of carbon from a natural gas-fired plant, 265 metric tons of carbon from a coal-fired plant and 220 metric tons of carbon from an oil-fired plant. Emission-free nuclear power plants discharge no carbon dioxide.[7]

Without nuclear energy in the generation portfolio, the reduction requirement needed to achieve the Kyoto Protocol target would increase significantly. Further, the Energy Information Administration (EIA) and industry analyses show that severe impacts to the nation's economic strength could occur if these goals are imposed, without taking full advantage of non-emitting energy sources like nuclear energy and renewable energy.

All told, the nation's 103 operating nuclear reactors accounted for about 20 percent of America's electricity production in 1999. This level is exceeded for 2000, as of September. By substituting for fossil fuels in electricity generation, in 1999, U.S. nuclear power plants achieved emission

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reductions in the approximate amounts of 1.9 million tons of nitrogen oxide, 4 million tons of sulfur dioxide, and 168 million metric tons of carbon.[8] The issues for policy makers are lack of an existing method to properly credit nuclear energy's clean air benefits in the marketplace and to address the inequities in federal support of nuclear technologies in comparison to alternatives, both in degree of internalization of environmental costs, and in funding levels for R&D.

Energy Diversity, Supply, and Demand

Nuclear energy is key to a balanced mix of electric energy resources in the U.S. and globally (fossil, hydro, renewable, and nuclear). Today, 103 nuclear power reactors produce 728 billion kilowatt-hours of electricity annually, which is over 20 percent of the total U.S. electrical supply. Since 1977, nuclear electric generation has nearly tripled while coal-fired electric generation has nearly doubled and generation from all other sources has decreased by 18 percent.[9]
Figure 1-2 shows the U.S. electricity mix. Figure 1-3 demonstrates that many states depend on

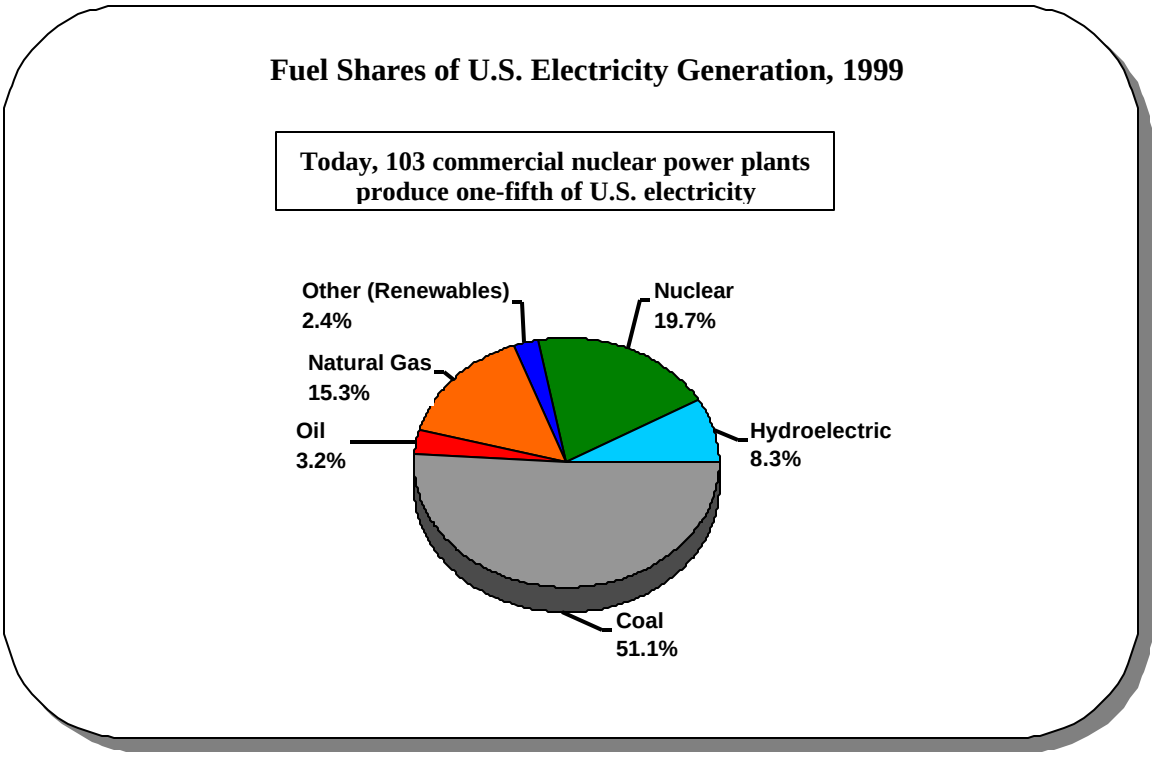

Figure 1-2: U.S. Electricity Mix
Source: EIA Electric Power Annual 1999

nuclear energy for the majority of their electricity. The role of nuclear power as part of a diverse, secure mix of electricity supply options is often demonstrated in times of crisis. In past years, when major floods hit the Midwest and extremely cold conditions occurred in the East, nuclear power plants in both regions continued operating while portions of the fossil fuel supply were interrupted. Decades ago, nuclear power plants provided critically needed electricity when Middle Eastern countries interrupted oil supplies to the United States.

8 Nuclear Energy Institute
9 Information Digest, 2000 Edition, USNRC

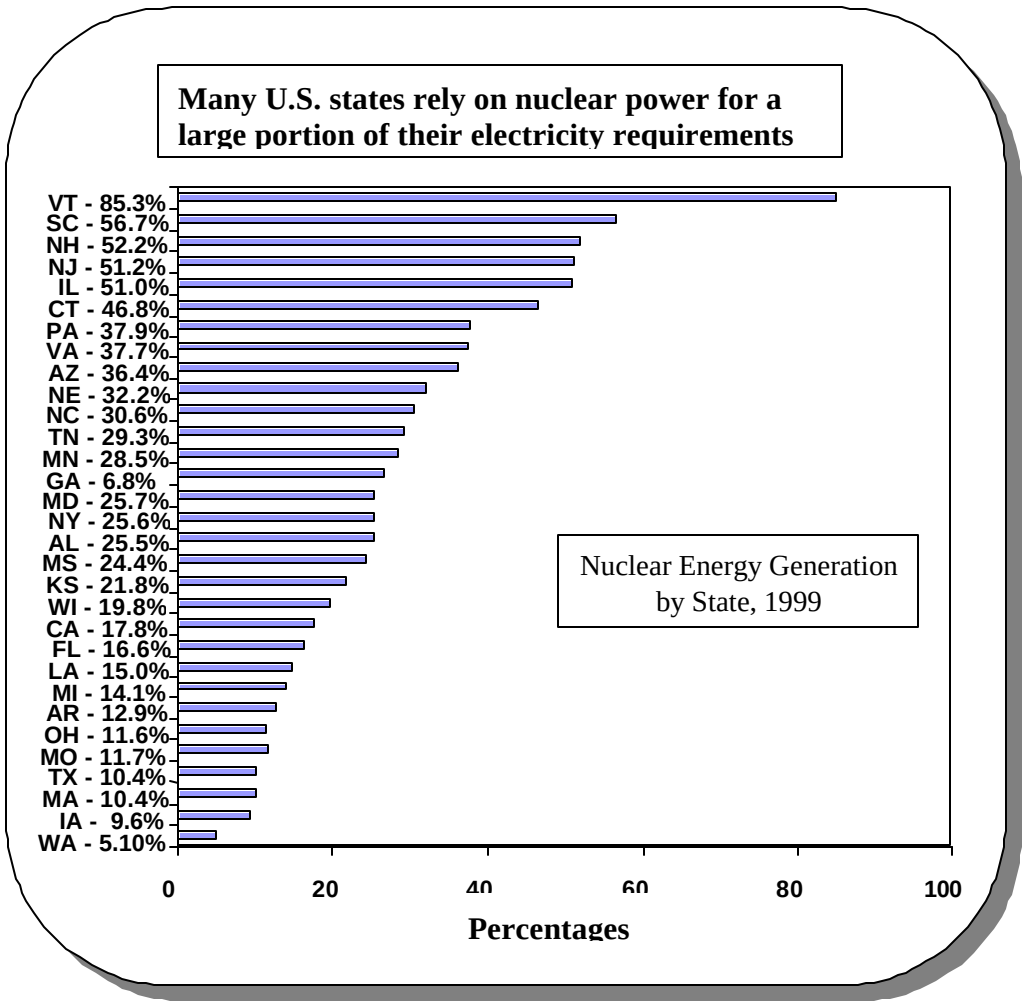

Figure 1-3: Percentage by state of electricity generation from nuclear energy
Source: NEI

In addition, electricity consumption in the United States continues to grow, making energy diversity even more important. The Department of Energy's Energy Information Administration (EIA) anticipates that, even with energy efficiency measures, U.S. electricity consumption will increase 1.4 percent each year through 2020 – the equivalent of building nine new large 1000-megawatt power plants every year. During this same period, the EIA projects approximately 89,000 megawatts of existing electricity generating capacity will be retired because of age and economics. This represents 12 percent of the United States' present electricity generating capacity.[10] Building these plants will require a huge economic investment in new baseload generating capacity, and when in operation, these new plants (if fossil plants) will emit large quantities of air emissions. According to EIA, nuclear energy could be key to reducing carbon emissions. As part of the projected retirements, EIA currently projects that approximately 40,000 megawatts or over 40 percent of existing U.S. nuclear generating capacity will retire by 2020. This appears to be contradictory to the recent events in an increasingly deregulated

10 Annual Energy Outlook, 2000, Energy Information Agency

electricity marketplace. The emerging marketplace has shown that current nuclear plants are a sound investment, suggesting that few if any will be shut down prematurely, and suggesting that virtually all current nuclear plants will achieve license renewal.

Continued operation of its existing nuclear power plants is an essential part of the U.S. energy diversity strategy. Nuclear power plants have operated safely and reliably in the United States for decades and are capable of continuing to do so for many decades to come. Continuing the operation of existing nuclear plants through their original license term and a renewed license term of 20 additional years will delay the need to build more baseload fossil power plants, thus avoiding substantial carbon emissions. R&D can play an important role in achieving this goal for all U.S. plants in the most cost-effective manner possible.

Utility Deregulation and Economics

Two years ago, most energy companies, energy policy-makers, and the investment community had major questions and concerns about the impact of deregulation of the electric industry – with its apparent emphasis on near-term economic payoff. It is becoming increasingly clear that for regions of the country with ample generation reserve, deregulation is good for the energy consumer because he/she has more choices and typically lower average electricity costs. Deregulation has caused a shakeout in generating assets, with the most reliable and cost-effective plants making the greatest profit. The precedent set by the many states that have completed deregulation thus far is that existing baseload capacity (e.g., fossil, nuclear) that was constructed under the prior regulated environment, should be allowed an appropriate amount of cost recovery for the construction costs previously incurred.

Deregulation has sharpened the focus on nuclear energy's problem of high capital cost. It has shown that capital costs for new nuclear plants are still too high to compete with natural gas generation. R&D initiatives to address this issue are promising, but currently beyond the scope of this Joint Strategic Plan. On the other hand, deregulation has had a very different effect on those nuclear plants that are already built and in operation, since deregulation works to the advantage of those generating assets with the lowest production costs going forward.

Nuclear energy has fared quite well in this sea of change, with the better performing plants in the U.S. emerging as some of the most competitive in the nation. Trends suggest that poorer performing plants will either improve their operations or be sold to larger nuclear generating companies that are better positioned to compete. Nuclear technology is sound and well suited for this new business environment. The realignment has been within the operating companies, seeking more efficient organization, staffing, and support services at more competitive prices.

Deregulation is not complete and issues remain to be resolved. The two most critical issues facing energy policy makers and the electricity business are: (1) grid stability and reliability under the increasing demands of dynamic power market sales and transfers; and (2) electricity price volatility in regions of the country without adequate generating capacity and reserve margins. Again, new technology is key to addressing these challenges.

Regulatory Process

The potential for major application of computer technology, computer-aided design, state-of-the-art instrumentation and control (I&C), advanced information management systems, new high-strength and corrosion-resistant materials, advanced fuel designs, etc., could lead to major opportunities for advancing new and existing power generating technologies, especially nuclear. Unlike most high technology energy sources, nuclear energy needs to demonstrate the viability of new technologies in a unique regulatory environment that has sometimes resulted in a long and costly approval process. In contrast, many technology improvements have been applied successfully and more rapidly to improve fossil fuel generation, where the unique regulatory environment that exists for nuclear power was not a factor. This contrast is an important consideration in justifying DOE's important role in assisting with R&D that supports technology infusion, particularly in areas impacted by equipment obsolescence and the relevant regulatory guidance. Further, nuclear energy is unique in that the full cost of its regulation is borne by plant owners through user fees. Most comparable regulatory costs (e.g., EPA) for other technologies are borne by taxpayers.

In the area of regulatory processes, fundamental change has occurred in the last two years. This change was not directed at the new technology infusion problem discussed above, but technology issues will benefit in the long run from the progress being made. The U.S. NRC has undergone a major change in direction recently because of its commitment to risk-informed regulation and to improved regulatory effectiveness, more efficient and objective processes, and more timely and realistic decisions. The NRC's revised Regulatory Oversight Process, governing the monitoring, inspection, and enforcement activities of the NRC relative to individual plants, is the most obvious example of change that has incorporated all of these attributes.

DOE and industry are confident that this approach to regulatory reform will help address the technology issue as well. Timely infusion of modern technology, with its advantages of higher reliability, greatly improved maintainability, improved human interface, and typically lower cost, is essential to nuclear energy keeping pace in the emerging dynamic electricity business. These modern technologies include cost-effective aging effects management, digital I&C, computerized plant configuration management, probabilistic safety assessment (PSA) techniques in support of risk-informed regulation, advanced fuel designs, etc.

Plant License Expirations

Licenses for U.S. nuclear power reactors begin to expire in large numbers in 2010; in 2014 alone, even after factoring in recent license renewals, licenses are scheduled to expire for 11 units representing about 10,000 MWe. While license renewal is primarily a business decision by the plant owner, continuing the operation of most or all of the nation's nuclear power plants clearly serves several important national interests associated with energy security, environmental quality, and economic strength.

Deregulation is reshaping the business structure of nuclear generation, encouraging the creation of separate nuclear generating companies. Mergers and acquisitions of these companies are forming even larger operating companies. The value of license renewal is becoming even more

apparent. Even for utilities that own nuclear plants but plan on getting out of the generation business, the business advantages of making sure their plant is capable and ready for license renewal greatly increases the plant's market value for sale to other nuclear generating companies.

The license renewal process requires further streamlining. For example, many technical issues that must be addressed for each renewal applicant still lack a generic, risk-informed resolution. Such problems cause unnecessary work and result in increased cost to NRC and industry. These costs are not a "show stopper" because license renewal still remains a cost-effective decision for owner-operators. However, the lack of generic, risk-informed resolution of all license renewal technical issues, creates large and unnecessary resource demands on NRC staff conducting the reviews as well as on industry preparing the submittals. It forces customized approaches to each issue for each applicant, as contrasted to a generic, or "template" approach. This affects the ability to process license renewal applications in a timely manner. Due to limited resources, NRC has asked industry to control the rate of applications to ramp up to no more than about eight per year. However, actual license expiration dates suggest that peak submittal rates could exceed this number.

DOE-EPRI cooperative R&D can help this situation by providing the data to reduce the uncertainties associated with aging issues that would enable generic and risk-informed resolution of technical issues. This would enable further streamlining of the license renewal process for future applicants and more cost-effective aging management programs for all plants. R&D can provide the foundation for more cost-effective operation of current plants in non-safety-significant parts of the plant as well -- systems and components that are not important to license renewal but that are still important to continued economic operation of the plant, and that still need effective aging management. R&D can address obsolescence of systems and components by providing current technology replacement parts, which are often safer, more reliable, and less expensive than original equipment.

Additional nuclear R&D will likely produce new technologies that will optimize plant operation and O&M processes during the renewed license term, making the plants much more economical. Examples of such cost enhancements include more cost-effective, advanced technology replacements for obsolescent equipment (e.g., advanced digital technologies for older analog instrumentation and controls); refined safety and plant performance analysis tools and technology that enable power upgrades; optimized fuel cycles that allow higher fuel burnup and less frequent refueling outages; and advanced inspection and repair technologies that reduce the time, cost, and radiation exposure associated with these tasks. All of these enhancements have indirect benefits in improved plant safety, although the primary focus of this R&D is on performance and economics, not safety research.

Further, nuclear energy R&D in the areas of enhanced reliability and plant optimization will help address national energy and environmental needs by increasing the probability that all current nuclear plants will operate safely and cost-competitively for a full 60 years, and by reducing the cost of electricity to consumers through application of state of the art technologies to continual improvement of nuclear plant operational effectiveness.

International Leadership in Nuclear Technology

A final issue of strategic national interest is the expanding role that nuclear energy will play in the world economy. As shown in Figure 1-4, many countries currently rely heavily on nuclear energy; and, as shown in Figure 1-5, the use of nuclear power internationally is projected to continue to expand over the next 50 years. This growth will be most dominant in the developing countries, where the desire is strong for safe, high performance nuclear technology. The expected increased use of nuclear energy by the developing world will help moderate the increased emission of greenhouse gases that will accompany the expansion of economic activity. For industrialized countries with currently operating nuclear plants, the technology developed under this strategic plan will be of direct use for overseas nuclear plants as well, and help improve their safety and economic performance, as they age and require new technology and aging management solutions. Thus, this Strategic Plan contributes to U.S. leadership in nuclear safety, environmentally superior energy technologies, and U.S. strength in global energy markets.

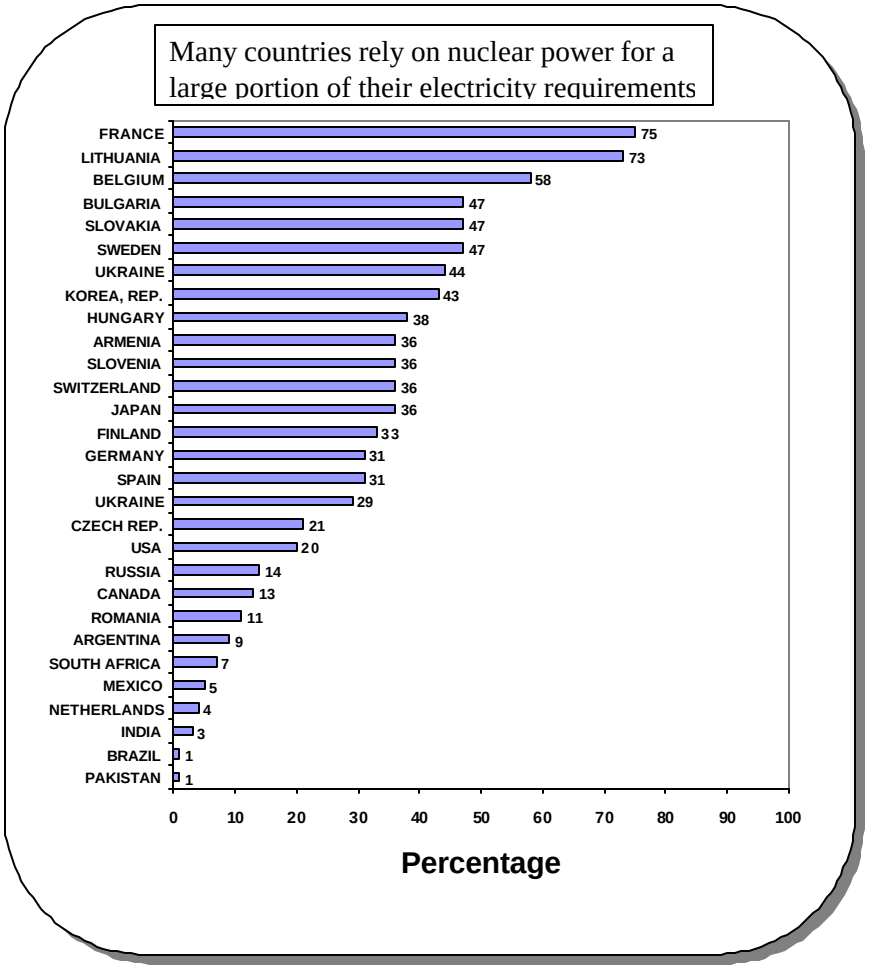

Figure 1-4: Share of nuclear energy generation in 1999, by country
Source: IAEA

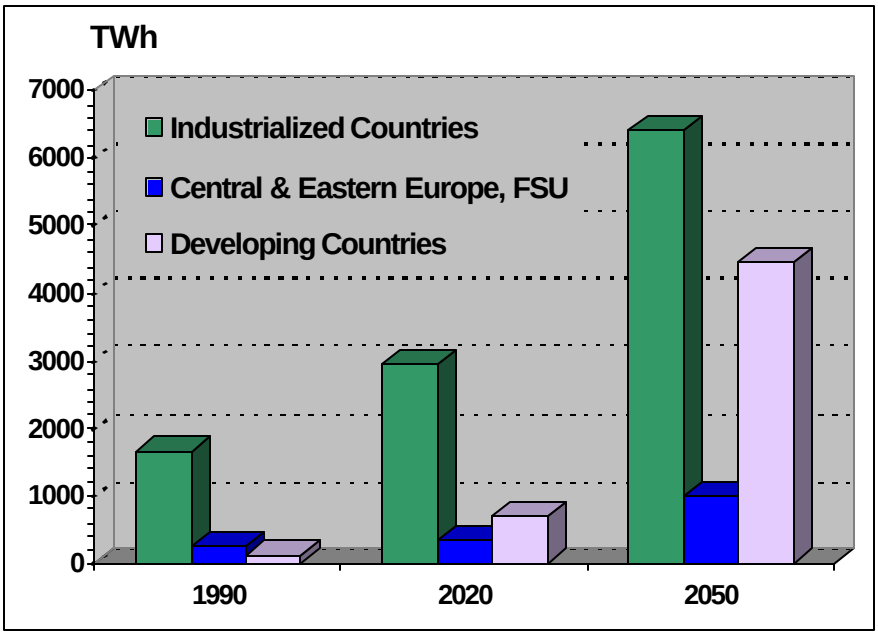

Figure 1-5: Projected World Growth of Nuclear Energy to 2050
Source: World Energy Council 1998 Report, "Global Energy Perspectives", Scenario B, "Middle Course"

Technical Issues

Current nuclear plants were designed and are operating with technology developed over twenty-five or more years ago. As these nuclear plants continue to age, components and structures age or become obsolete, introducing inefficiencies or added costs. Component and structural material degradation occurs in nuclear plants as a result of long-term operation and exposure of materials to harsh environmental conditions. Material degradation occurs in harsh conditions that include radiation and elevated temperature and pressure environments in the reactor pressure vessel, reactor internals, steam generator tubes, system piping, structures, and electrical cables. These components incur degradation over time in the form of corrosion, heat and stress related fatigue and cracking, and reductions in fracture toughness due to neutron irradiation and thermal embrittlement. These material degradation mechanisms have been anticipated but are becoming evident due to the age of operating nuclear plants. Research will provide a better understanding of each degradation mechanism and how it occurs, enabling development of new cost effective aging management strategies (or enhancements to existing aging management strategies) which will provide improved capabilities to more effectively prevent, detect or repair the degradation.

There have been significant technology advancements over the past twenty-five years that provide more accurate, reliable, and cost-effective capabilities, and that are applicable to power generation, particularly in computers, communications, human performance, artificial intelligence and digital electronics, advanced materials, etc. Many of these advancements came from our Nation's defense and space research programs. Some of these advancements have already been installed in some of today's plants, demonstrating the cost-benefit of new technologies.

GOALS & OBJECTIVES

The strategic guidance for the development of this Joint R&D Plan was obtained from the market assessment of commercial nuclear energy technology requirements that support critical national needs. For the purpose of framing this strategic R&D plan, a set of Strategic Goals and Objectives was drawn directly from the goals and objectives of two DOE and EPRI Strategic Plans issued prior to the first edition of this Joint Strategic Plan in 1998. These goals and objectives have been reviewed carefully in the process of developing this 2000 update, and deemed appropriate for continued guidance for Joint R&D collaboration, with only minor editorial changes. This review included a review of more recent strategic planning references, such as EPRI's Electricity Technology Roadmap, NEI's Strategic Direction for the 21st Century, the second PCAST Report on Energy and Environmental R&D, etc.

The goals and objectives in the two original-source Strategic Plans, the *Nuclear Energy R&D Strategic Plan in Support of National Nuclear Energy Needs* (June 1997, EPRI), and *The U.S. Department of Energy Strategic Plan* (Sept. 1997, DOE), are consistent with the major national nuclear policy guidance provided in the Atomic Energy Act, as amended, and the Energy Policy Act of 1992. A number of other federal and industry studies of energy R&D needs were also considered in the development of this Plan. Each of these studies is described in Appendix B, with emphasis on the recommended contributions nuclear energy R&D should have on the future energy supply of the nation. Appendix C provides more detail on the R&D goals and objectives from the DOE and EPRI Strategic Plans, from which the goals and objectives for this more narrowly focused Strategic Plan were extracted.

These goals and objectives are organized into three program elements, each with a number of R&D tasks. Thus, the R&D task areas included in this Plan are directed to the specific technology needs that follow from this goal-based review of national requirements, principally those goals related to ensuring the cost-effective operation and life cycle management of currently operating nuclear plants. In general, this R&D is focused on near-term and medium-term technology development to conform to the recommendations of PCAST. The goals and objectives within the scope of this Strategic Plan address the technology issues and opportunities that face current U.S. nuclear power plants. R&D Objectives listed below that come from other sources are so noted.

Goal 1: Ensure current nuclear plants can continue to deliver adequate and affordable energy supplies up to and beyond their initial 40 year license term, by providing a strong technical basis for long-term operation, by resolving open issues related to aging mechanisms, and by applying new technologies to improve the cost-effectiveness and predictability of the life cycle management process.

R&D Objectives

1. Conduct sufficient R&D on nuclear plant aging phenomena so as to provide utilities and NRC with the generic information and methods needed to measure, predict and control long-term material conditions. Develop and demonstrate effective methods for aging assessment and management.

2. Provide technology solutions that support achieving at least 90% of current plants applying for and receiving NRC approval for license renewal. (Source: Keynote speech, Dec. 99 NERAC Long Term Nuclear R&D Workshop, G. Rueger)

3. Maintain and expand critical materials research in order to be prepared for new issues related to the performance of existing plant equipment (particularly, long-lived, passive components and structures), and to be prepared with repair and replacement options based on technologies that have been tested and approved by NRC, ASME, etc.

4. Resolve any remaining generic technical issues that arise during NRC review of license renewal applications.

Goal 2: Ensure current nuclear plants can continue to deliver adequate and affordable energy supplies by continuing to develop and apply the best technology to enhance nuclear plant reliability, availability and productivity, while maintaining an adequate level of protection of the health and safety of the public.

R&D Objectives

1. Improve nuclear power plant reliability and availability, in order to further increase the capacity factor of current nuclear power plants. (based on DOE Strategic Plan Objective 2, Strategy 7)

2. Develop new state-of-the-art technologies that will enable all nuclear energy plants to maintain economic competitiveness. Focus should be on advanced I&C, advanced information management systems, advanced man-machine interface and human factors engineering, organizational factors and human performance, and advanced inspection/repair technologies.

3. Develop new technologies and analytical methods that can allow safe, reliable power up-rating of existing plants, e.g., through changes in administrative limits while not compromising safety margins.

4. Develop new techniques and supporting research and development to help ensure continued improvements in plant performance and efficiency. (Source: A Strategic Direction for Nuclear Energy in the 21st Century, NEI, May 2000)

5. Assure the continued availability of reliable and economic nuclear fuel designs. This includes optimizing the economics and performance of current nuclear fuel designs, and developing advanced LWR fuel cycle designs that can achieve higher burnup/longer life, greater fuel utilization and higher reliability. (see DOE Strategic Plan Objective 2, Strategy 7)

These two goals contain both short and medium-term R&D objectives. In general, the short-term objectives (i.e., less than 5 years) are primarily the responsibility of industry. The medium term objectives (i.e., 5-10 years) are typically shared between industry and government. These goals correspond generally to program elements (chapters) in this Joint R&D Strategic Plan, with Goal 1 mapping to chapter 3, and Goal 2 mapping to chapter 5.

Strategic Plan Elements

The goals and objectives of this Joint DOE/EPRI Strategic R&D Plan were evaluated to establish the task areas and individual tasks which need to be performed in order to achieve the strategic goals of this plan. The tasks, once identified, were grouped into three sections, one for each of the following plan elements:

Plant Aging: Conduct R&D to understand, characterize, and manage or mitigate effects of plant aging on key plant components, such as reactor pressure vessels and vessel internals, steam generators, electric cables, primary system piping, and safety-related concrete structures.

License Renewal: Develop technologies to reduce the costs and regulatory uncertainties for license renewal.
(This original Plan element is being retained as a "placeholder" for potential future use; this Plan Update specifies no R&D tasks under this element.)

Generation Optimization: Develop and demonstrate technologies to optimize the power output from existing nuclear power plants, e.g., develop NRC-licensable replacements for outdated analog instrumentation and controls, self-checking/calibrating sensors, fiber optic technology, and on-line diagnostics and information management systems. Develop and demonstrate technologies in other areas that will enhance the safe and cost-effective operation of current plants, in areas such as human performance, advanced nuclear fuels, etc.

Future R&D Goals

Longer-term goals for nuclear energy, primarily related to building new plants, also derive from the DOE and EPRI strategic plans. They also derive from the “U.S. Nuclear Energy Industry Strategic Plan for Building New Nuclear Power Plants” (last published in 1998), from the "Strategic Direction for the 21st Century" published annually by NEI, and from the draft NERAC Long Term R&D Plan for Nuclear Technology. These goals are not currently

addressed within the scope of this Joint Strategic Plan. There remains a need to expand the long term goals listed below into the joint DOE-Industry Planning and cost-sharing arena.

Future goal: Provide competitive nuclear energy generation options to meet medium term (5 to 10 years) requirements for adequate and affordable baseload capacity.

R&D Objectives:

1. Maintain a viable nuclear option for future, carbon-free baseload electricity through cooperative technical development activities with U.S. electric industry that would facilitate a U.S. order of an advanced nuclear power plant by 2010 (DOE Strategic Plan Objective 2, Strategy 8).

2. Provide technologies to enable an increasing nuclear share of U.S. installed capacity by 2020.

3. Identify innovative techniques, approaches, and R&D needs to reduce the capital and operating costs of new nuclear plants and the time required to place them in service. (Source: A Strategic Direction for Nuclear Energy in the 21st Century, NEI, May 1999)

4. Maintain effective, ongoing processes for transfer and application of technologies developed for advanced reactors to meet current plant needs, and for application of solutions developed for current plant issues to enhance future plant options (EPRI Corollary Goal #13).

5. Evaluate options for further advances in the ALWR designs in the current ALWR program, to meet future contingencies. Possible contingencies that could require a commitment to more advanced ALWR developments include:

    - Future market requirements for passive ALWRs with a smaller or larger than 600 MWe plant electrical output

    - Innovations to improve ALWR electrical production efficiencies.

(Note that longer term advanced reactor design goals and objectives are covered in DOE's Long Term Nuclear R&D Plan developed by NERAC, and by EPRI's Electricity Supply Roadmap.)

Future Goal: Support U.S. energy, environmental, and economic interests in global markets. (DOE Strategic Plan Objective # 4).

R&D objectives:

1. Apply the U.S. technology used to address the above goals to foster increased international trade in U.S. nuclear technologies (EPRI Corollary Goal # 14).

2. Cooperate with foreign governments and international institutions to develop open energy markets, and facilitate the adoption and export of clean, safe, and efficient energy technologies and energy services. (DOE Objective 4, Strategy 2). Specifically, support implementation of U.S. government agreements with Asian-Pacific countries that open enhanced market opportunities for U.S. nuclear industrial suppliers, enabling them to exchange information and export U.S. light water reactor technology and services.

SUMMARY

The R&D activities included under this Joint Strategic Plan are critical to meeting the nation's goals of an electricity supply that is not only secure and affordable, but also free of harmful air emissions. Additionally, federal R&D to sustain the continued operation of existing nuclear plants is a prerequisite for the United States to preserve a viable and expanding nuclear energy component to its energy supply. By helping to ensure long-term operation of existing nuclear power plants, this Joint Strategic Plan is serving strategic national interests for economic strength, energy security, and environmental quality. Together, the Department of Energy's Nuclear Energy Plant Optimization (NEPO) program, and the Nuclear Energy Research Initiative (NERI) are paving the way for continued and expanded use of nuclear energy in the future, and helping the U.S. retain world leadership in nuclear technology.

The R&D performed by the nuclear industry - totaling approximately $90 million each year - is critical to the maintenance of safe and economic operation of U.S. nuclear power plants. Yet, the nuclear industry has been forced to invest the bulk of its R&D spending on short-term activities that are needed to enhance day-to-day operational performance and to respond to regulatory issues. The nuclear industry cannot afford the mid-to-longer term R&D necessary to under-pin this short term focus. This confirms the unique role for DOE in nuclear energy supply R&D — one that industry has strongly and consistently supported.

The electric utility industry leadership and the national policy makers with planning or budgetary responsibility for nuclear energy R&D are the primary audience for this Plan. Both support preserving the strategic and economic advantages of a mix of energy supply options competing on an even playing field in a free market. Both are acutely aware of the need for reducing the cost and increasing the market value of R&D. Accordingly, both share common objectives, and this encourages joint planning and cost-sharing – where appropriate – of R&D being transitioned to the private sector. Government and industry recognize that they must work in partnership to effectively implement any long-range national energy strategy.

DOE and industry continue to believe that nuclear energy R&D that supports the continued availability of a safe, predictable, and cost-effective nuclear option for U.S. power generation is of critical importance to the nation. In addition to maintaining this option as an essential part of the U.S. response to environmental issues associated with the burning of fossil fuels, nuclear energy provides an essential hedge against energy fuel price and availability fluctuations in our nation's diverse mix of energy technologies and fuels. Success in these R&D programs will sustain U.S. leadership in nuclear technologies to safely extend the life of currently operating plants around the world. Continued U.S. leadership will ensure the high standards of nuclear

safety and reliability that mark U.S. technology will continue to lead in global markets -- enhancing our nation's security and economic interests.

Industry is making major strides to bring the performance of all of our nation's nuclear power plants to the highest levels of safety and performance. Further progress will require, in part, more investment, particularly in new technologies that can further improve the performance and reduce the costs of nuclear generation. This Joint Plan is key to continued improved performance.

DOE and EPRI undertook the challenge in 1997-98 to review carefully the prior individual plans for the nation's nuclear energy R&D programs; and to jointly develop a single, comprehensive nuclear energy R&D strategic plan that is fully supported by the leadership of both organizations and by the owners of nuclear plants, that meets the intent of the PCAST recommendations, and that will be understood and supported by the Congressional leadership responsible for energy R&D programs. That challenge was met, and an important guiding document was created that has formed the basis for a successful Nuclear Energy Plant Optimization program at DOE, cost-shared by industry. This update builds on that success by refining the needs and opportunities for nuclear energy R&D from a marketplace perspective.

This Joint Strategic Plan, in conjunction with DOE's complementary initiative for longer-term R&D projects—the Nuclear Energy Research Initiative, are restoring health and purpose to the nation's nuclear R&D agenda. To implement this plan, DOE and EPRI need the continued input and support of the nation's electric utilities, national laboratories, the colleges and universities with nuclear engineering and research programs, and the many other elements of the nuclear industry with expertise in nuclear energy R&D. Cooperation with the NRC will also be expanded to ensure that research is coordinated, not duplicated, and that it achieves the goals of this plan.